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Spin correlations and colossal magnetoresistance in naturally layered manganites*

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Colossal magnetoresistance in optimally doped manganese oxides is believed to involve a strong coupling among spin, charge, and lattice degrees of freedom. Studying the interplay between these correlations is greatly facilitated in the layered manganites $La_{2-2x}Sr_{1+2x}Mn_2O_7$, in which the reduced dimensionality increases the importance of fluctuations and extends the temperature region of significant correlations. Using neutron scattering, we have studied in detail the magnetic correlations in the $x = 40\%$ hole doped bilayer compound. In the paramagnetic region above $T_C \sim 113K$, the in-plane correlations obey standard two-dimensional scaling with a crossover towards three-dimensional critical behavior close to T_C, consistent with a conventional quasi two-dimensional phase transition. This suggests that conventional critical spin fluctuations drive the phase transition while simultaneously destroying the charge correlations observed in the paramagnetic region. Nevertheless, the evolution of the out-of-plane spin-correlations and the anomalous behavior of the susceptibility close to T_C as a function of temperature and external field as well as the unusual small value of the order parameter below T_C provide evidence for an increase of the double exchange at the onset of charge delocalization.

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